SD1209: Novel Wind Turbine

Advised by: Dr. Bei Gou

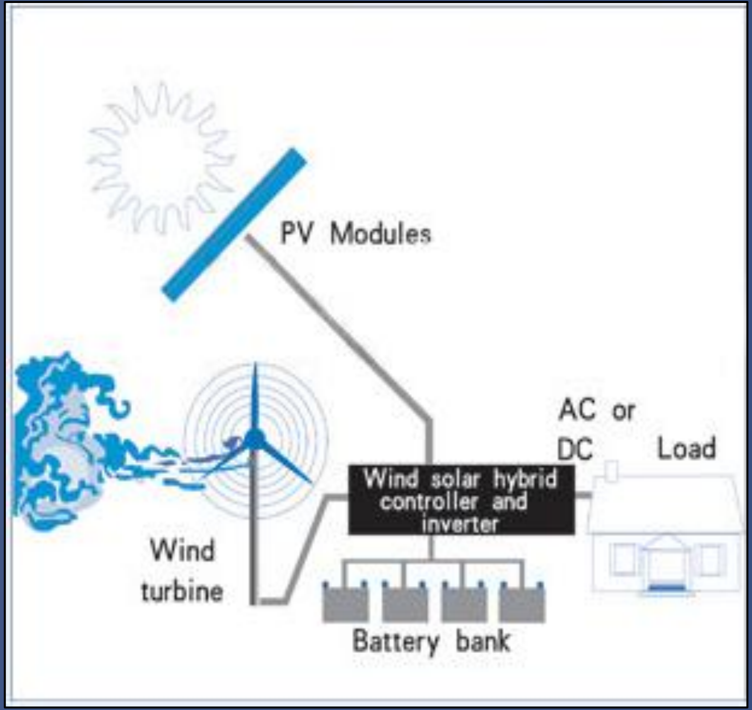
Surabhi Gandhi, Kevin Moen, Jake Heck

Introduction

- **Aim:** To build a Solar Hybrid Wind Turbine system, including a unique "Receiver design". Be able to test the system with/without the receiver and compare results.

- **Working Principle:**
  - **Receiver:** Be able to direct wind into the turbine
  - **Wind Turbine:** The wind turbine and panels generate electricity, charge into battery through controller, the system supply power in AC for different loads

- **Applications:** Both Commercial and Non Commercial applications.



Additionally

- The solar hybrid wind system should be :
  - A cost effective alternative
  - Smaller size, equal output
  - More efficient
  - Able to operate at lower wind speeds
- The system includes an interactive receiver design

Requirements – Project

- Supply continuous 150 W with 13.2 V battery backup
- Utilize alternative energy
  - Wind
    - Design AC to DC converter
    - Regulate output
  - Solar
    - Regulate output

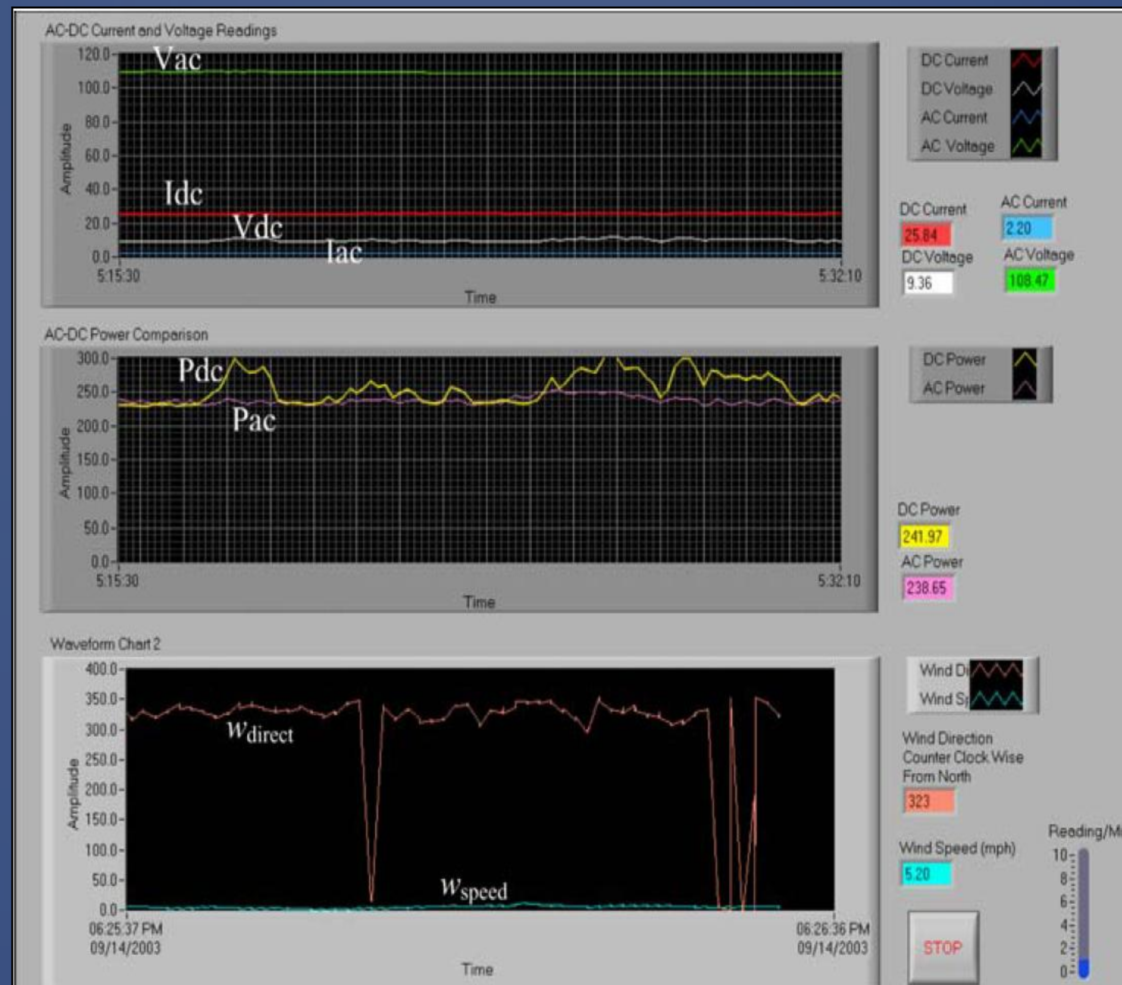
Requirements- Receiver and Turbine

- **Receiver**
  - Outer cone diameter of 1.6 meters
  - Minimum height must be higher than tallest crop
    - Approximately 3 meters
  - Withstand high wind speeds without damage according to standards
  - Increase maximum output of the current generator via altering the controller
  - Capable of rotation

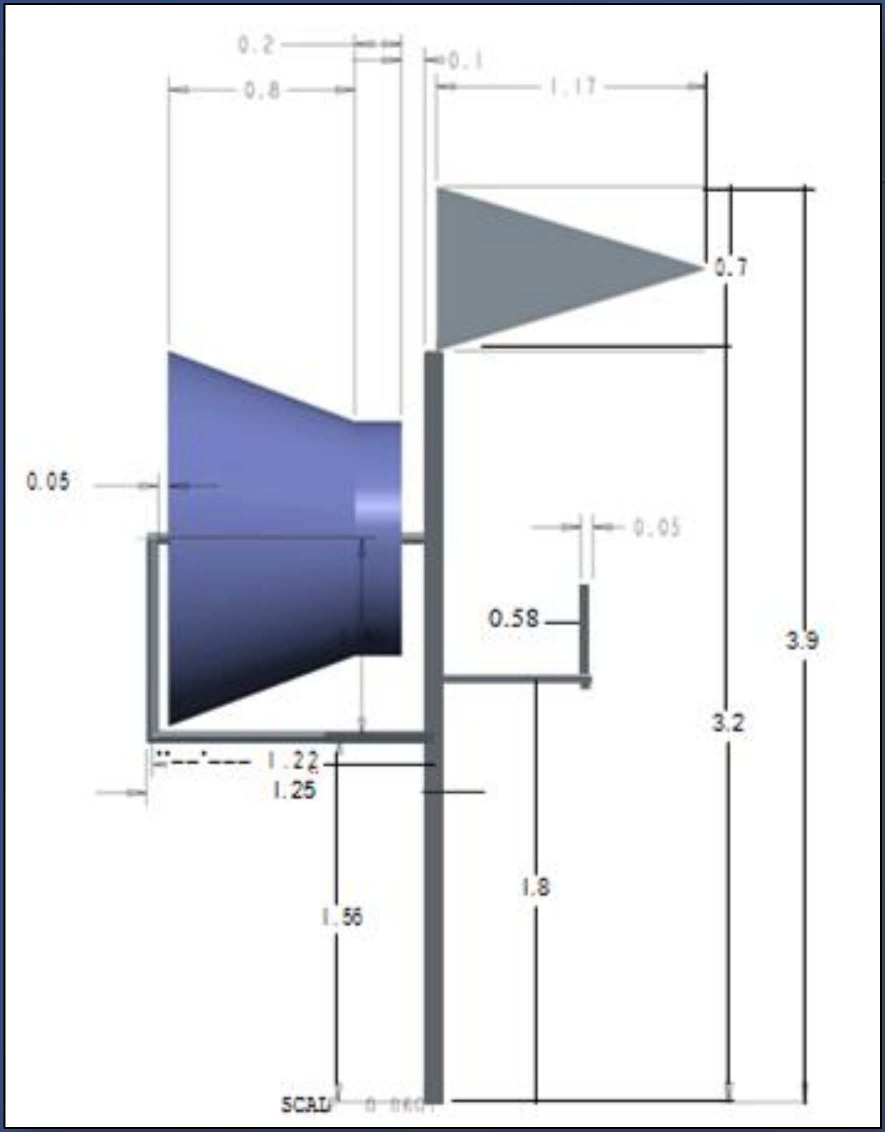
- **Wind Turbine**
  - Equal or higher power output compared to larger turbines
  - Much lower startup cost
  - Operate at lower wind speeds than conventional turbines
  - Operate at higher wind speeds without breaking

Requirements – LabVIEW

- Design a code capable of :
  - Graphing input wind speed vs. output wind speed
  - Graphing voltage and current output from turbine
  - Comparing power output of turbine vs. output wind speed and time.
  - Collect and store data



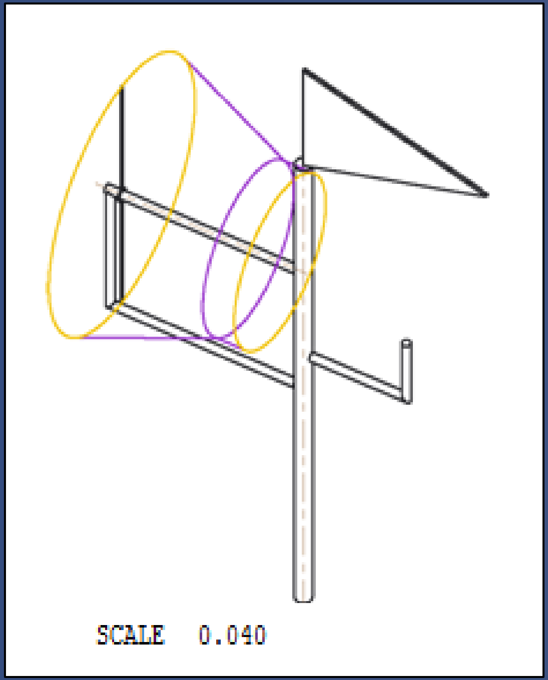
Receiver system



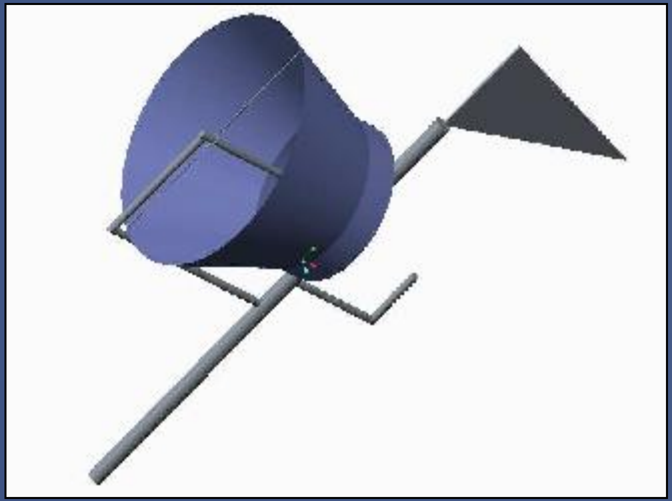
Receiver dimensions

- Receiver Dimensions
  - Outer diameter: 1.6 meters
  - Inner diameter: 1 meter
  - Total length: 3.9 meter
  - Able to rotate? : yes
  - Wind tail dimension: 0.7*3.
  - Cone thickness: 0.2 m

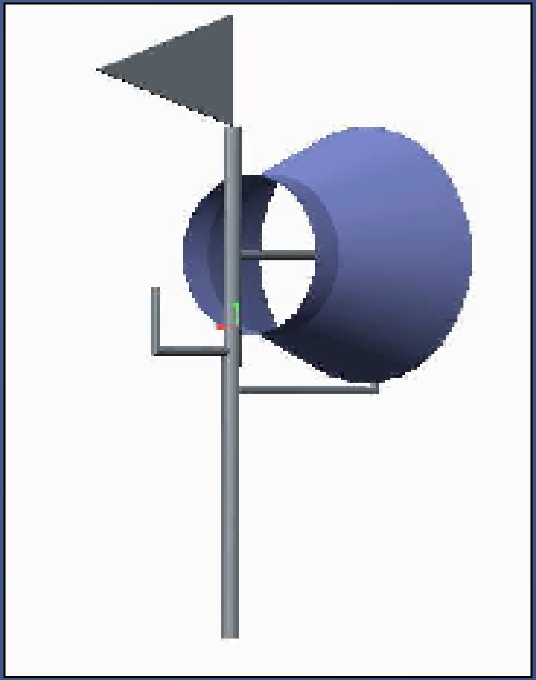
Receiver Views



Isometric view



Front View, to show rotation



Back View

Materials

- We can use various materials to build the cone. However we need to make sure the system is light weight and robust.

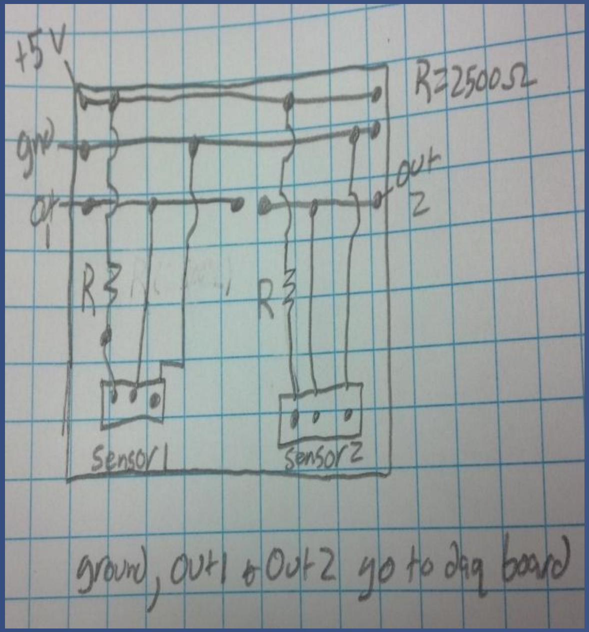
Material	Advantage	Disadvantage
1)Steel	Strong	Expensive
2)Aluminum	Light, Strong, Weather resistant	Above Average Cost
3)Plastic	Cost Effective	Weak if light
4)Carbon Fiber	Very Light, Very Strong, Weather Resistant	Highly Expensive.

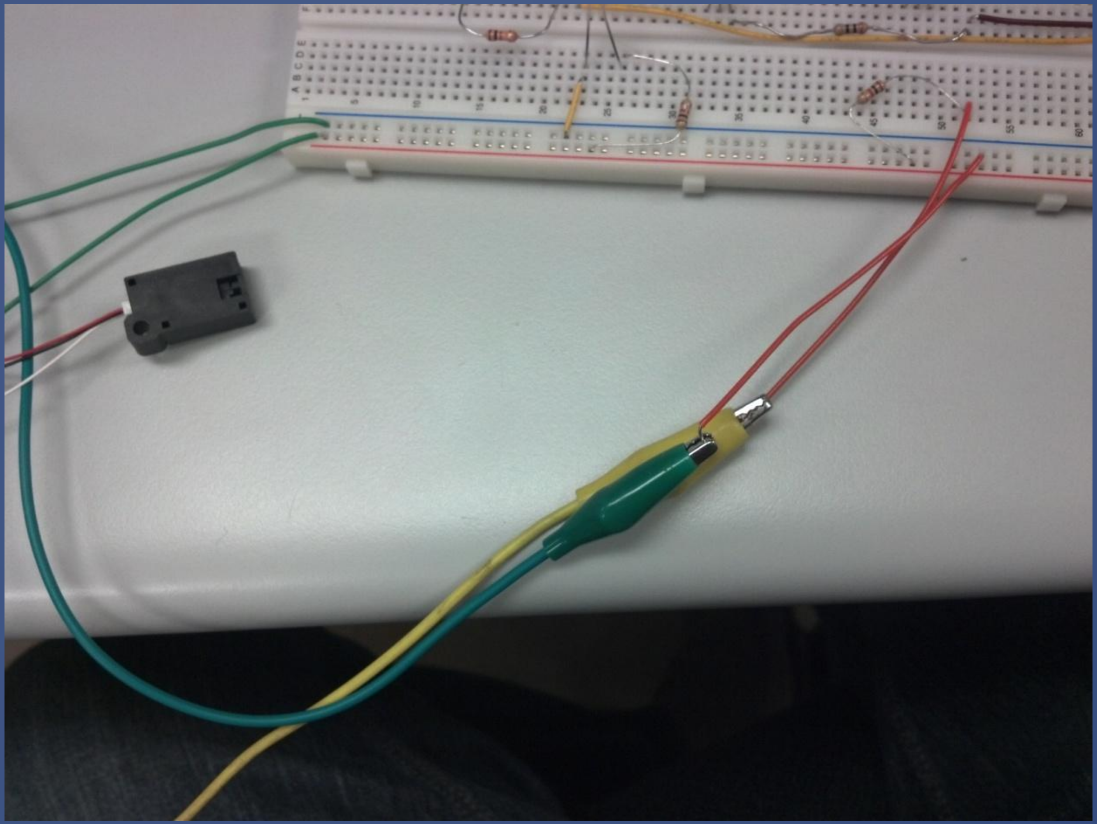
- Finally, we decided to use Plastic as the material on Dr. Gou's recommendation.

Sensors

- We tested multiple sensors ranging from wind speed, single pressure and dual pressure switches
- The wind speed sensor worked best however it is limited to only 7 mph

Sensor circuit layout





AC to DC

- The 3 phase AC output from the generator needs to be converted to DC in order to charge the battery.
- This will be done with a rectifier, we will be taking a 3 phase, variable voltage, and variable frequency output and convert it to DC regulated to 13.2 volts to charge a battery without overcharging it.

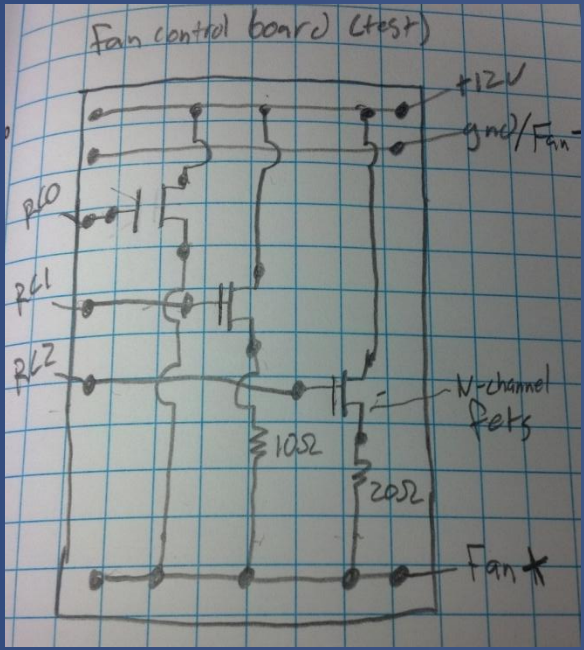
DC Regulation

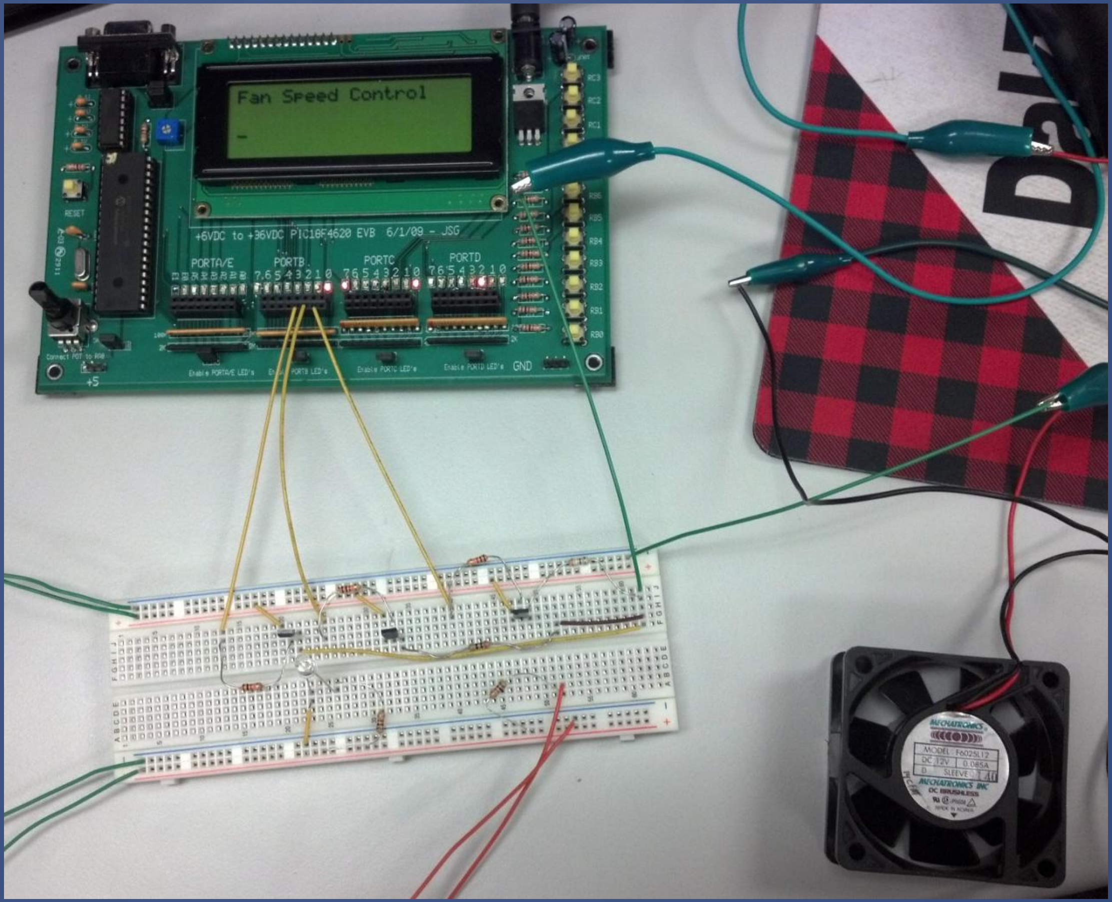
- Maintain constant voltage level to protect battery
  - Combined the AC to DC rectifier
- Solar Panel will need it's own separate regulator circuit

Fan Speed Control - Test

- In order to control the fan we have a circuit that is PIC controlled to vary the resistance on the power going into the fan, in turn varying the power output.
- Currently we are using N- channel FETs to vary resistance in our circuit.

Test Fan Control Setup



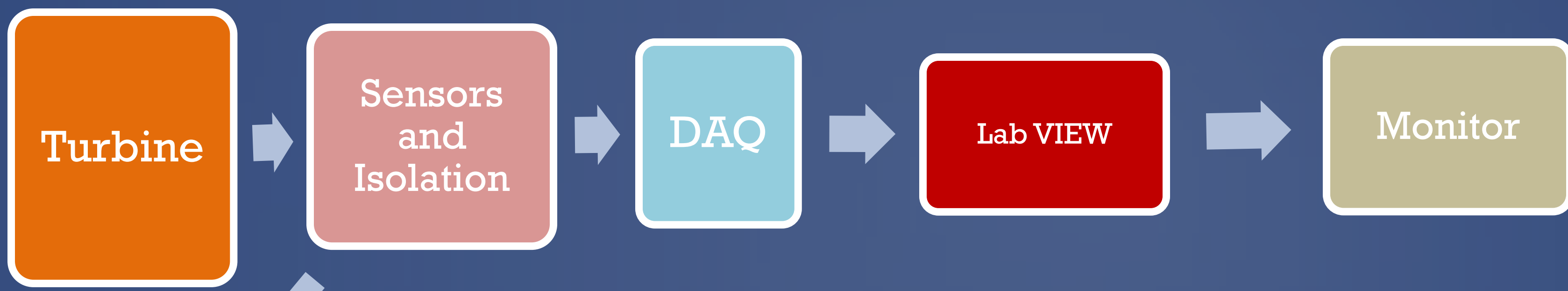


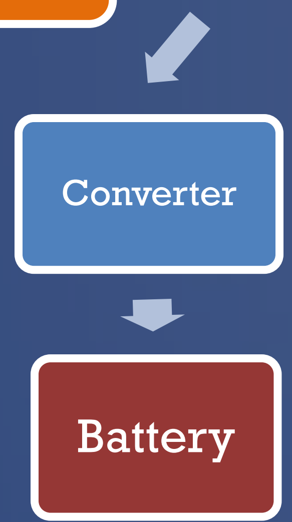

```
while(1){
if (RC1==1){
                    STEP=STEP+1;
   P = (STEP % 4);
   PORTB = DATA[P];}
else {
   P = (STEP % 4);
   PORTB = DATA[P];}
Wait_ms(300); }
```

Fan Speed Control - Future

- In the future we are looking at using high amperage relays to switch the fan speeds rather than FETs.
- We are also looking at the possibility of using Pulse Width Modulation to vary the power input to the fan again using a PIC to control it.

LabVIEW Data Acquisition



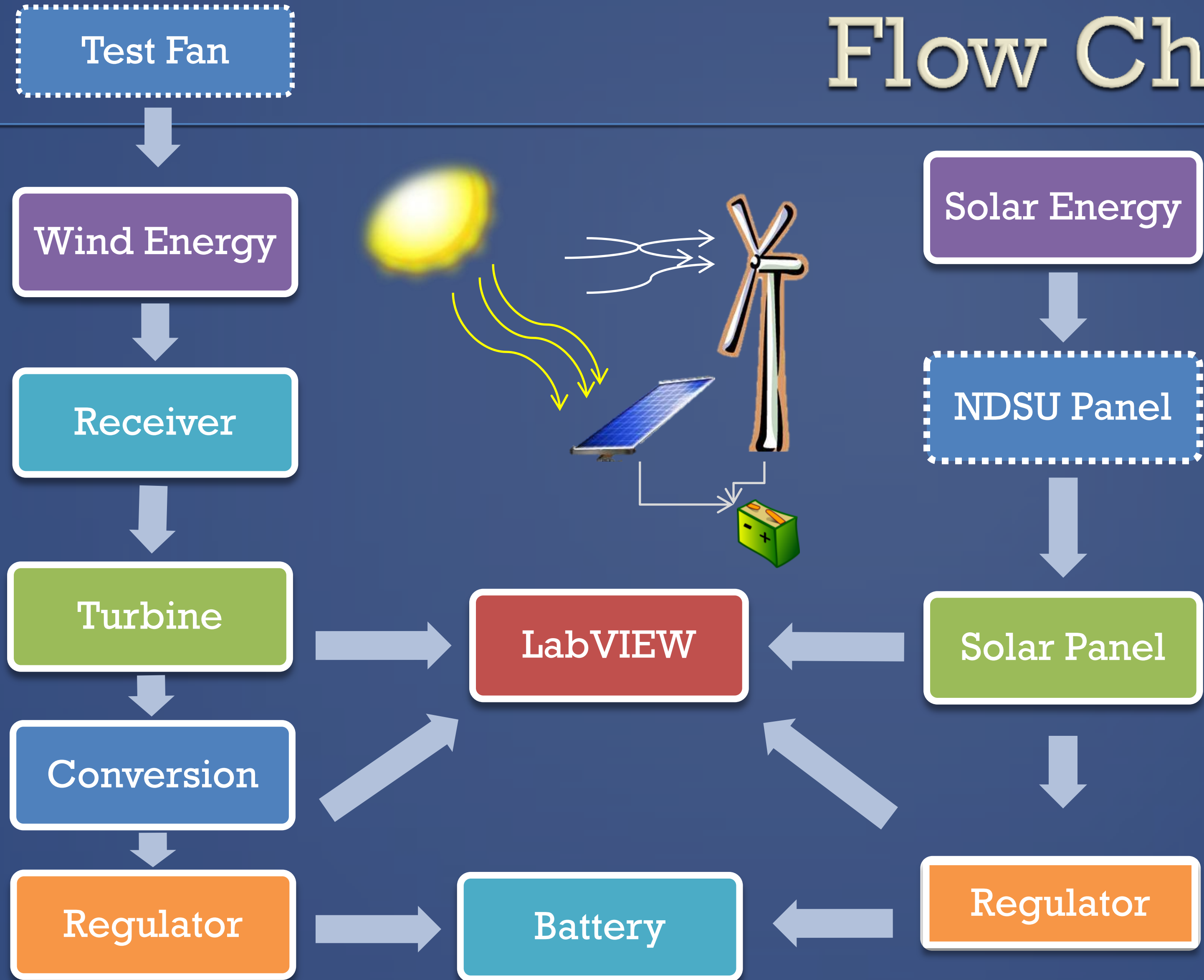


- LabVIEW will be used to acquire the data produced from the sensor circuit using a data acquisition (DAQ) unit.

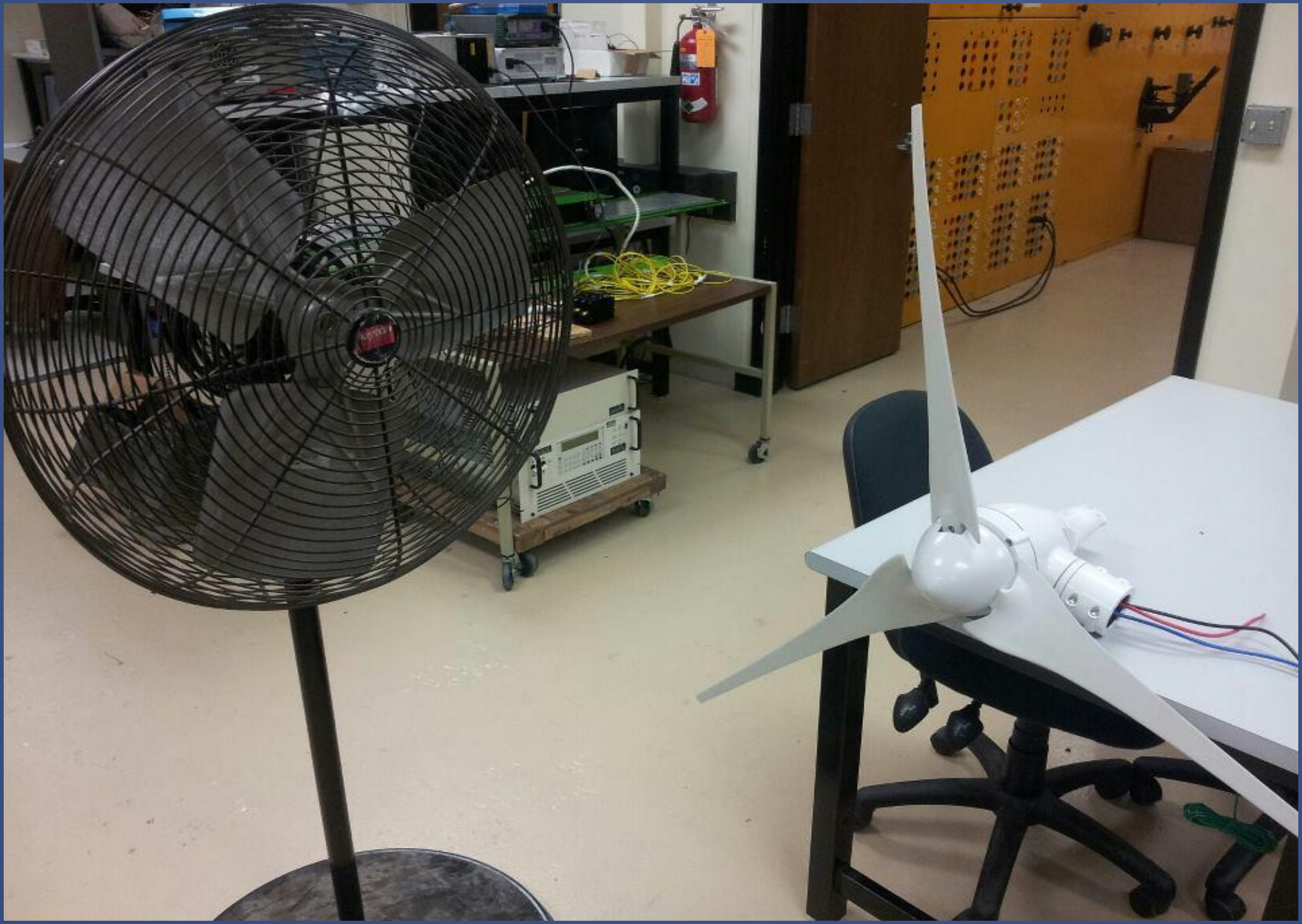
- The DAQ device available in the ECE department is from National Instruments. It has 37 pins to work with and is a 16 bit data acquisition device.

- Once we have the sensors set up on the wind turbine, we would be able to write a code for the same on LabVIEW.

Flow Chart


Test Fan
Wind Energy
Receiver
Turbine
Conversion
Regulator
LabVIEW
Battery
Solar Energy
NDSU Panel
Solar Panel
Regulator

Project Status



Tasks Remaining (In Order)

1. Fan Controller
2. AC to DC converter
3. Regulator
4. LabVIEW data acquisition
5. Receiver
    1. Test receiver – Electrical metallic tubing (EMT)
6. Re-analyze
7. LabVIEW comparison

Budget

Part	Quantity	Cost per unit	Projected Cost	Actual Cost	Notes
Wind turbine – 400 W	1	$305	$305	$305	Ebay
Solar Panel – 60 W	1	$130	$130	$130	Ebay
Receiver	1	$550+	$550+	$550+	Dr. Gou
12 V battery	1	$100	$100	$0	ECE Dept.
PIC18F4620 microcontroller	1	$85	$85	$0	Kevin
Test fan – 24 in.	1	$251	$251	$0	ME Dept.
Z2629-ND Airflow sensor	2	$26	$52	$0	ECE Dept.
		Total	**$1473**	**$985**	

- Approved budget - $1200
- Receiver - $50/hour + materials

Summary

- After weeks of research we have established that the Novel Wind Turbine is a unique design and shows great potential.
- We are now ready to build the controllers and begin testing next semester.
- Due to project uncertainties we got off to a slow start, however we feel we have made back ground and are set to be on schedule for the upcoming semester.

Questions?